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The CHEMIST

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Publication of The AMERICAN INSTITUTE of CHEMISTS

In This Issue

Frank W. Douglas

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Northrup Clarey

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Norris W. Matthews, F.A.I.C.

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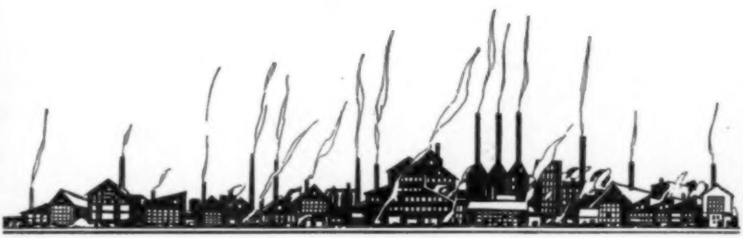
Institute Notes



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Chemistry at Colorado College

By Frank W. Douglas

Outlining the development of the Department of Chemistry in a small college in the Rocky Mountain area.

COLORADO College was established in 1874 and is located on a tract of land granted for the purpose by the founders of Colorado Springs. The pian was "to build a college in which liberal studies may be pursued under positive Christian influences," but without "ecclesiastical or political control." The ideal aim seemed to be "a Harvard in the Rocky Mountain region." It has developed into a college of the smaller type with excellent educational facilities, and high educational standards. It is the only institution of its type in the Rocky Mountain Region.

The first building on the campus, now known as Cutler Hall, was occupied in 1880. The same year William Strieby became Professor of Chemistry and Metallurgy. The chemical laboratory was located in Cutler Hall until 1903 when it was removed to its present location in the east end of Palmer Hall. Professor Strieby was a graduate of the University of the City of New York and the Columbia School of Mines, being trained in both chemistry and engineering. He played a very important part in the development of the Cripple Creek mining district. The chemical laboratory and especially the assaying laboratory became the center of mining developments. He also did much toward the development and utilization of the mineral springs of Manitou, Colorado. Dr. Strieby had a fine appreciation of good laboratory equipment. A large measure of credit is due him for the good laboratory facilities with which the college is supplied.

Last year the college began operation on what has been termed the "Colorado College Plan." The lower division of the college forms the "School of Arts and Sciences" which includes the freshman and sophomore years, and is somewhat similar to a Junior College. It is intended to give a broad general training and to orient the student into college life. The upper division is divided into three schools, Natural Sciences, Social Sciences, and Letters and Fine Arts. The aim is to provide intensive training, a high degree of adaptability to the individual needs of the student and to make original and independent scholars. Its effect on the chemistry department appears to be the removal of restrictions which have tended toward mass instruction, better satisfied students and recognition and stimulation of original effort. It may be said the principal goal of the chemistry department is to produce men and women who can and will intensively investigate a problem, in library or laboratory, without direction or aid from others.

AS IN all institutions of this type, the demands on the chemistry department are extremely varied. Besides meeting the needs of chemistry for general culture, premedic training, and for training in the departments of geology, physics, and biology, its interests, conforming to the needs of its major students, are spread over a variety of fields. Mainly these are teaching, biochemistry, chemical technology, industrial chemistry, chemical engineering, metallurgy, research, and graduate work. Their demands must be met without duplication, or multiplication of courses, as number of students and size of the teaching staff prohibit such. The problem is solved largely by means of fundamental courses, so intensive that they adequately meet the requirements for all purposes. The student is generally satisfied with such treatment of the subjects, and experience seems to show that a thorough training in the fundamentals, even though considerably greater than essential, is, at least, as satisfactory as a less intensive training in a larger variety of subjects.

General chemistry must meet the needs of three types of students. First are those, beginning this subject, who are majors in some science and who need it as part of their preparation. This demand is met with a fairly intensive course of standard type extending through the year. The laboratory work (two afternoons per week) is devoted to inorganic preparations the first semester, and to qualitative analysis, principally of the cations, the second semester. The second year these students take quantitative analysis along with those who have studied chemistry in high school. This group is facing extinction because not more than ten per cent of our students enter without high school chemistry.

The second group consists of those who have studied chemistry in high school, and who choose it to meet a science requirement, but do not expect to pursue science studies further. This group generally objects to intensive laboratory work. No special provision is made for this group at present. Formerly, the demand was met by combining this group with the next for class work, but giving only one afternoon of laboratory work. The latter consisted of especially selected inorganic preparations, designed to supplement the high school work and to arouse interest. It appears necessary to adopt this plan again.

The third group consists of the majors in science, including majors in chemistry and the premedics. The course offered appears to be somewhat unique. Believing the historical method of presentation to be the most interesting and convincing, this plan is followed through the development of the quantitative relations including the atomic-molecular theory and atomic weights. Especial attention is called to the development of the scientific method of study. The remainder of the first third of the year is devoted to the study of the structure of matter including gases, liquids, solids, solutions, and colloids. This work is almost entirely physical chemistry. The balance of the year is taken up with the study of descriptive chemistry, especial emphasis being placed upon industrial processes.

EARLY in his career, the author was impressed with the encyclopædic character of descriptive chemistry as usually presented, and the hopeless confusion of a large part of the students. It seemed that, if Mendeljeff could predict the existence of unknown elements and describe them with such great accuracy, the student should be able to use the periodic system to give him a fair working knowledge of the elements and their compounds. Moreover, the author found his own mind working in this way on the less familiar elements. Out of this conviction, has grown the author's method of presenting descriptive chemistry. Starting with a thorough study of the periodic classification, now based principally on atomic structure, the author has endeavored to work out the chemistry by groups, showing the similarity of chemical and physical behaviors, and the variations and tendencies within the group. It has been found that in this way it is possible to bring practically every student to the point where he can give a satisfactory description of the chemistry of an element, which, to him, is itself unknown.

In the laboratory, it was found nearly every student had had an excellent course in inorganic preparations, and was bored by a continuation of this work through another year. The accompanying laboratory course, as now offered, consists of about seven weeks (two afternoons per week) of quantitative experiments illustrating the quantitative relations of chemistry and is followed by the qualitative analysis of the anions during the remainder of the first semester, and that of the cations during the second. This plan has saved a year of the student's time without perceptibly lowering the standards below those attained by a sophomore course in qualitative analysis.

The sophomore year is devoted to quantitative analysis. The varying needs of the students are met by dividing the work in the second semester into a course in technical analysis for those inclined toward the industries and one in clinical technology, by cooperation with the Biology department, for premedics, and those interested in biochemistry. A year's work in organic chemistry is given in the Junior year. This includes about four hours per week in organic preparations.

The senior year is varied more to meet the needs of the individual student. A year of physical chemistry is required. This includes one afternoon per week of laboratory work, which is designed to familiarize the students with apparatus and methods in daily use, rather than to illustrate general principles. A popular course is one in quantitative organic analysis during the first semester followed by qualitative organic analysis in the second semester.

VARYING interests are met by giving in alternate years or as demand requires such courses as: industrial chemistry, physiological chemistry, history of chemistry, advanced inorganic chemistry, and assaying. Another device is well-outlined laboratory courses which may be worked out by the student without much demand on the time of the instructor. Such largely independent work has been found very effective in developing students who are capable of pursuing it with profit. Individual work is also encouraged by a "Topics" course in which any suitable subject may be chosen to suit the student's interest. The work consists of an intensive study of the subject in the library with weekly conferences. This method has often proved surprisingly effective in developing thoroughness and independence.

As far as possible each student is induced to take a year of research work before graduation. Research in the department has been pursued largely for the purpose of developing interest and teaching methods of attack, rather than for making real contributions. Not much has been completed and published but fifty-six per cent of the graduates in the last ten years have continued for graduate work, mostly in other institutions with the aid of assistantships. Subjects of thesis presented are: temper carbon and the transition point of amorphous carbon and graphite, water supplies and mineral waters of the Pike's Peak Region, volatile matter in the coal of the region and methods of determination, low temperature carbonization of the coal and composition of the gas and tar, systematic qualitative analysis of anions, chemical conditions in the juices of plants at high altitudes, oxidation and reduction, a rapid method for electrometric titration, a study of burners used for natural gas.

In response to efforts of the National Research Council, there has been established at Colorado College an honorary research fraternity known as Delta Epsilon. Its purpose is to recognize and encourage originality and research ability as differentiated from general student ability, and ability to get high grades. Experience has shown that this group has included nearly all of the students who have continued in graduate and research work, and the percentage of such workers in the organization has been very high. Some effort has been made to nationalize the organization as the field served does not seem to be met by any other national fraternity. There are now four chapters.

Chemistry in Colorado College should be of more than local interest. The institution is peculiarly cosmopolitan. Many young people threatened with tuberculosis, asthma, and certain other ailments have found they could come to this region, pursue their studies without much handicap, and in a great majority of cases, effect permanent cures while the degree was being won. No doubt there are large numbers of young people throughout the country who should avail themselves of the peculiar health conditions of this region to correct physical tendencies while their education is being completed. This can be done at little or no extra cost above that in institutions nearer home. Records made by graduates of Colorado College apparently assure the student that the training received will not be inferior to that of institutions with which he is more familiar.

The New York section of the American Chemical Society is busy in preparation for the forthcoming Spring Meeting of the Society which will be held in New York. Institute members who are active in the plans include D. D. Jackson, D. P. Morgan, J. M. Weiss, L. W. Bass, Florence E. Wall, and others.

Oil in The Chemist's Test Tube

By Northrup Clarey

After many years of development along empirical lines, the petroleum industry has applied scientific research to its problems, with astoundingly rapid progress in chemical technology as the result.

DOWN in East Texas, where oil derricks grow in the middle of cornfields, a group of New York executives came across a queer contraption. It consisted of an old steel barrel covered with clay, mounted horizontally on four piles of bricks with fire burning below. From one end of the barrel a pipe curved outward, bending into a coil which was immersed in water in an old-fashioned rain barrel, and emerging as a spout, under which containers were placed to catch the various products of this primitive "refinery." Even a "testing laboratory" had not been overlooked. Two or three tomato cans lay about, and in these the stillman would catch samples coming from his outlet. The next step was to toss in a lighted match. If the liquid ignited, the product was gasoline (of sorts); if nothing happened, it was probably kerosene.

All of which might be cited to prove that the oil industry of today is not 100% reliant upon the chemist. But that would still leave it 99.75% dependent. Before the chemist was brought from his obscure garret or university workshop to be installed in the white-tiled laboratories and carpeted board rooms of an enlightened industry, the oil man was used to tossing into creeks under cover of darkness "waste leavings" from his crude oil which today yield him millions of dollars in valuable finished products—gasoline, among them. The measure of the chemists' worth to the oil industry is the difference between raw petroleum which quacks used to sell a credulous public as medicinal oil, and the refined white medicinal oil of today; between gasoline which flowed unwanted down the rivers back of early refineries, and the powerful fuel which today drives 26 million engines on American roads; between waste sludges in the bottoms of early stills, and thousands of useful specialties in industry and the home; between gases that formerly were allowed to escape into the air and the whole series of fuels, alcohols, and other products into which they have been changed under the magic wand of the chemist.

In petroleum the chemist has met a foeman worthy of his steel, for after more than seventy years of painstaking study comparatively little has been learned about the chemical make-up of this elusive mixture of hydrocarbons. Here is the essence of what test tube and retort have yielded regarding the nature of petroleum: While the types of hydrocarbons vary with the origin of the crude, in most cases the lower fractions consist chiefly of paraffines ranging upward from methane. Little is known of the chemical composition of intermediate cuts. Some are partly paraffinic in character, while others are naphthenic. The composition of the heavier compounds is still an unplumbed mystery. While it is true that the chemist has come across simple paraffine hydrocarbons of high molecular weight in considerable quantities, particularly in the so-called paraffine-base crudes, it is probable that the greater portion of the paraffinic constituents exists as radicals linked to ring compounds, these rings being either naphthenic or aromatic in character. On the average, analyses of various types of crudes have shown that the proportion of hydrogen to carbon is about as two to one. Naturally the hydrogen content of the lighter fractions is considerably higher than this ratio, with the carbon content increasing with the boiling point as we go down through the line of petroleum derivatives.

ONE of the first tasks that the chemist was called upon to perform in the petroleum industry came with the discovery of the Lima oil fields in Ohio, which were the first extension of producing areas beyond the borders of Pennsylvania. Lima crude, while prolific enough, turned out to be high in sulphur content. Nobody worried about such matters as valve corrosion in those days, there being no automobiles to speak of, but sulphur dioxide was not welcomed as a companion by those who were wont to sit at home evenings and read by the light of a kerosene lamp. Lima crude dropped to almost nothing a barrel until Dr. Herman Frasch showed the industry how to eliminate the objectionable element. Sulphur removal is too familiar a story to need further elaboration here. It is important to note, however, that the new hydrogenation process, which will be discussed a bit farther on, quite effectively removes sulphur as hydrogen sulphide in the course of operation.

As the quantity of whirling rubber increased on the highways of the United States and as new roads began to wind through picturesque parts of the country, inviting the growing army of motorists to come out and play, the chemist came face to face with a first-class problem. Any refiner with a real knowledge of his trade could get a good gasoline yield from crude—that is, good for those days. But there was a point beyond which even the most skillful could not go, being limited in his operations to straight fractional distillation or steam distillation. We can gain some appreciation of the importance of the chemist's discoveries in increasing the gasoline yield from a barrel of crude oil when we realize that as recently as 1920, when the cracking process was about eight years old, the percentage of gasoline that the refiner was able to extract would have been insufficient to satisfy today's demand for this product even if based upon current crude production.

THE outstanding contribution of the chemist to increase of gasoline yields from crude oil is the so-called "cracking" process, pioneered in this country by Burton, in which the molecules of the heavier fraction hydrocarbons are partially decomposed or "cracked" in the course of distillation, then "re-formed" into new molecules of lower series position, corresponding to those found normally in the gasoline fractions. This molecular degradation and rearrangement is accomplished by selection of suitable pressures and temperatures for the distillation procedure. The discovery of this process probably had its inception in the observation that, when raised to high temperatures, the heavier fractions of petroleum became unstable and their molecules "cracked," even in ordinary distillation. Further investigation has shown that this molecular dissociation of petroleum hydrocarbons can be accomplished in either the vapor phase or the liquid phase.

In some cases the crude is "topped"—that is, the lighter products are distilled out in the usual way, and the remainder run to the cracking coils; in others a gas oil is used as charging stock for cracking. Temperatures of 600° C. at atmospheric pressure, or somewhat higher, are usually the order in vapor phase cracking, while in the liquid phase pressures range from a few hundred pounds to as high as 1,000 pounds at temperatures of 400° to 500° C. The higher the temperature employed, the higher the pressure required to give a true liquid phase system by solution of the lighter ends in the liquefied heavier ends, and in many processes ordinarily referred to as "liquid phase" the pressure employed is not sufficient to prevent a substantial percentage of the cracked products from accumulating in the form of vapor. Because of the high temperature and low pressure employed, products resulting from vapor phase cracking are rich in aromatics. In fact, by employing temperatures of 600° C. and higher, it is even possible to build up aromatics from the paraffins of low molecular weight which are present in natural gas. In such instances the gaseous paraffins are first broken down to olefines, which then yield aromatic compounds such as benzene, naphthalene, anthracene, and their derivatives through the polymerization process, accompanied by the liberation of hydrogen. As far as is known, however, the process of converting gaseous paraffines into aromatics has not yet been utilized on a commercial scale, although there is plenty of evidence that intensive efforts have been made in this direction. Through the work of the petroleum chemist and mechanical improvements in the cracking process, the yield of gasoline has increased from about 20% in pre-cracking days to an average of 50% today, without consideration of the hydrogenation process. The man in the laboratory has had no time to rest on his laurels, however, for increasing the quantity of motor fuel was not the only problem he has been called upon to solve.

For some years automotive engineers have been gradually increasing the compression of the power plants they have tucked into each new crop of cars and, in fact, have gone so far as to promise even higher compression motors as soon as the oil industry shall provide a fuel capable of operating them. All this has led to an exhaustive study of the whys and wherefores of motor knocking from a chemical standpoint, and of what can be done to remedy it. In the past it was assumed that the tendency to produce detonation (motor knock) decreased in the hydrocarbon series in the following order: (*a*) paraffines, (*b*) olefines, (*c*) naphthenes, (*d*) aromatics. Thus the increased formation of aromatics resulting from vapor or liquid phase cracking at high temperatures is highly desirable, since it reduces the knocking tendency of gasoline. However, indications today are that the influence of molecular structure on detonation is so marked as to outweigh any effect attributed to the various series. In general it has been found that branched hydrocarbons are better knock suppressors than straight chains. Taking all these conclusions together, the modern refiner leans toward operations at higher temperatures in liquid phase cracking, as well as toward the development of true vapor phase processes at lower pressures for the purpose of improving the anti-knock quality of motor fuels, by increasing the yield of aromatics and branched chain compounds.

A STORY is told in connection with the drilling of an early gas well in New York State around 1865. Four hundred and eighty feet below the surface a crude string of drilling tools had dropped into a pocket. There was a dull rumbling, like distant thunder, which swelled into a roar until there burst from the mouth of the well a mighty column of mud, oil and water, borne on the driving fist of a tremendous pressure that rocketed tools and everything high into the air. The drillers cheered. At last, after two years of tedious effort, they had struck oil. But their cheering was short lived. For the dark stream soon thinned out and then disappeared altogether, leaving only a colorless substance escaping into the air with a roaring noise that seemed to mock them. The well was a failure, it seemed. They had struck not oil but gas. It has taken us a long time to realize the true value of natural gas and its companion, refinery gas. In fact, it is probable that even now the mine of their usefulness has only been tapped. But let's see what the chemist has done about it.

Roughly estimated, some fifty-three billion feet of natural gas is available daily in the United States. Its composition ranges from nearly pure methane to mixtures containing upward of 60% ethane, propane, and higher hydrocarbons in gradually decreasing amounts. Refinery gases—produced, of course, in much smaller quantities—contain hydrogen and unsaturated compounds, in addition to saturated hydrocarbons. Unfortunately, natural gas hydrocarbons are highly resistant to chemical change—methane, which is available in by far the largest quantities, being the worst in this respect. This stubbornness among the gaseous paraffines necessitates operation at temperatures where the products of reaction are generally exceedingly unstable. Moreover, the lower the hydrocarbon the more difficult it becomes to stop reactions at a specific point and to isolate the desired products, and that characteristic has proved a serious obstacle to the chemical utilization of methane and, to a less extent, of propane and butane. The more important reactions that natural gas hydrocarbons undergo may be classified as cracking, oxidation, and halogenation. The unsaturated hydrocarbons, which are much more reactive, are subject also to addition and polymerization reactions.

A discussion of the chemist's work with natural and refinery gases would take a volume in itself. The net result, however, has been to extend the field of usefulness of these gases considerably beyond that of fuel. Metal cutting gas is one commercial product which has its origin in the natural gas fields; so-called "bottled" gas—a mixture of propane and butane—is another useful commodity which serves many communities where the laying of a pipeline system is not commercially justified. A whole series of industrial alcohols has been developed, using natural and refinery gases and the lighter hydrocarbons. Today there are at least four different alcohols of petroleum origin on the market—isopropyl, secondary butyl, secondary amyl, and secondary hexyl—and from them numerous valuable commercial derivatives have been made. Among these are liniments, hair tonics, rubbing alcohols, perfumes and cosmetics, lacquer solvents, rubber solvents, rust removers, and so on. Several primary alcohols also are made from natural gases.

WHAT is generally conceded to be one of the outstanding groups of technologists in the American petroleum industry is centered in the laboratories of the Standard Oil Development Company at Bayway, N. J. It has branches at Baton Rouge, La., Baytown, Texas, and Sarnia, Ontario, and there are probably more than a thousand persons engaged in research and development for the company and its subsidiaries here and abroad. A leading contribution of the Standard laboratories to the petroleum world, generally considered to be one of the most important discoveries ever made in this field, is the now famous hydrogenation process. The principle of the process, which was originated by Bergius in connection with the hydrogenation of coal, was developed by the I. G. Farbenindustrie. It was later brought to the United States by the Standard and its application to petroleum was further developed after an exhaustive program of research lasting several years.

As applied on a commercial scale in the two Standard Oil hydrogenation plants now in operation, the process has achieved the following important results:

(*a*) Improved quality of lubricating oils and kerosene
(*b*) Nearly complete conversion of heavy refinery residues into distillate oils
(*c*) Removal of sulphur and stabilization of cracked naphtha
(*d*) Production of high yields of high octane number gasoline from paraffinic gas oil.

Where the gasoline yield from crude under even the most favorable conditions may extend to about 70%, hydrogenation has been shown capable of increasing the yield to 100%. Here is another important function of the new process. Because of the rapid production of gaseous products (hydrogen, methane, ethane, etc.) of high hydrogen content, there is left behind in the process of cracking petroleum much heavy material, such as tar and coke. To reduce the formation of these undesirables to a minimum, the refiner is obliged to crack with the least possible time of contact at any given temperature, and this leaves him with only a limited opportunity to regulate the structure of his liquid products. The introduction of high pressure hydrogenation solves this difficulty by bringing the hydrogen-carbon ratio under control. With proper operation the flexibility of the system is such that aliphatic-type hydrocarbons may be converted into naphthenes and aromatics with high efficiency, and vice versa.

Another notable achievement of Standard Oil Development laboratories within recent months has been in the lubricating oil field. For years the general public has been convinced that a good motor oil must be dewaxed to give proper service in the crankcase under winter driving conditions. It was known, however, that the natural wax content of paraffine-base oils is a valuable aid to good lubrication but that some method should be devised to prevent the congealing of the product at low temperatures. Research in the company's laboratories led to the development of Paraflow, a hydrocarbon oil which, when mixed with the best grades of paraffine motor oils, showed the following results:

(*a*) It lowered the pour point from 30° F., for example, to zero; (*b*) permitting the presence of a certain amount of paraffine wax in the lubricant, it tends to maintain a more constant temperature-viscosity index; (*c*) in cold weather its presence has been found to speed up the distribution of the oil from pump to bearings; (*d*) from the refiner's standpoint, it eliminates the necessity for expensive treating processes for the removal of excess paraffine wax. This development is now on a commercial basis, production of the product being carried on at the Bayonne refinery.

OTHER accomplishments of the chemist in the oil industry which are too important to overlook are the development of insecticides, the working out of various treating processes for removing impurities, improving the color, odor, and other properties of finished products, and the devising of standard, simplified tests for the presence of explosive mixtures. The latter has been invaluable in forestalling the possibilities of explosions. In the old days before testing apparatus was as common as it is today there was a story of a system used by a certain ship operator abroad who had more originality than common sense. After an oil tanker had been pumped out and it was desired to free the tanks of gas so that workmen might descend for repairs or cleaning, this operator would first rig a windsail into the tank to blow out the accumulation of hydrocarbon gases, then toss red-hot rivets into various parts of the tank. If there was no explosion it was perfectly safe for men to descend; if there was—well, it didn't matter then, anyway. Whether or not you believe the story it is a fair measure of the importance of the chemist's work in this direction to compare the former haphazard methods with the compact yet accurate testing outfits in use today.

Looking into the magic ball of the future is a fascinating, if risky, business. So many developments are possible in the laboratory which are impracticable on a commercial scale. So many synthetic processes are perfectly feasible from every standpoint, but will never see actual use unless something happens to shut off the supply of the natural product. It is interesting, however, to consider a few of the rabbits which the petroleum chemist has in his hat ready to draw forth should the economic need for them ever arise. Without a doubt the greatest contribution that the chemist has made toward the future of the petroleum industry has been to assure it a virtually indefinite supply of raw material. Even the known reserves of crude oil, geologists tell us, are sufficient to keep the world in gasoline and lubricants, asphalt and greases, for many years to come. Now, thanks to hydrogenation and the work of the chemist, we can add to this natural storehouse the almost unlimited deposits of coal and shale.

Interesting developments in by-products are foreseen in the modern-day trend toward synthesis, and in improvements in the use of pressure and catalysts. No longer, for example, need we resign ourselves to an insurmountable wall between aromatic and aliphatic chemistry. Formerly coal tar was looked upon as the very foundation of the former, while petroleum was supposed to belong to the realm of paraffines and the more obscure naphthenes. Very few bridges existed between the various groups of hydrocarbons, one of the most noteworthy being the conversion—although on a laboratory scale only—of benzene into cyclohexane and vice versa. Now we find aromatic derivatives produced by the hydrogenation of petroleum and by cracking and polymerization of gaseous paraffines. On the other side of the picture there is the formation of essentially non-aromatic tar in the low temperature carbonization of coal. Through these and similar developments there is ample opportunity, when economic conditions permit, for the synthesis of more valuable by-products.

So the chemist's activities multiply. He can never afford to roll down his sleeves and take a rest. There is always some new problem, either arising from refining practice or resulting from some new demand in any one of the countless industries which petroleum serves.

The Rôle of Chemistry in Modern Life

By Norris W. Matthews, F.A.I.C.

"The chymists are a strange class of mortals impelled by an almost insane impulse to seek their pleasure among smoke and vapour, soot and flame, poison and poverty, yet among all these evils I seem to live so sweetly, that may I die if I would change places with the Persian King."

Johann Joachim Becher (1669)

CHEMISTRY shares with physics and mathematics the really fundamental positions among the arts and sciences. Chemistry deals with the changes of matter and its characteristics and properties under a wide variety of conditions. Therefore, its work can be traced in all forms of human endeavor. Only in quite recent times has the larger portion of the public begun to realize the enormous part the science of chemistry plays in our modern life. The Great War created an interest in what scientific men had been doing and what could be expected of them. Since then the desire to learn more of their ways and doings has been growing slowly more insistent. Scientific men are themselves learning of this desire on the part of the public and are assisting the good cause themselves by supplying interviews and technical papers to the press and magazines.

There is scarcely one single article that we use or object with which we come into contact that has not been discovered, or its manufacture supervised by chemically trained men, during some part of the process. In a broader sense than in almost any other science, chemistry touches our everyday lives and makes them richer, happier, and more beautiful. Researches in chemistry are bringing to light discoveries that are enabling to be brought to pass heretofore unheard of and unbelieved things for the benefit of all mankind.

IN THE basic and fundamental industry of agricultural pursuits, chemistry has worked marvels. The growth of plants is itself a very delicately balanced chemical process. By means of simple methods the soil can now be investigated and analyzed and results obtained which state very definitely in just what condition the soil is, what crops it will grow to best advantage, what fertilizing materials are needed and how much should be applied, and in some outstanding cases, the crop itself is chemically tested to learn whether or not it is producing the maximum yield. Sugar cane and sugar beets are typical examples. We may add right here that chemistry plays a most important part in refining sugar satisfactorily and economically. The refining processes are controlled absolutely by chemical means. Linen, hemp, and other plant materials used in the manufacture of textiles are bleached by chemical methods. The mechanical equipment used in preparing the soil and in harvesting the crops is manufactured of metals and alloys made by men under strict chemical supervision. Every batch of steel, brass, or other alloy is just like the preceding batch and may be expected to behave similarly.

Fertilizers are natural or artificial mixtures of ingredients which, under the action of water, warmth, bacteria and other influences, transfer their active components to the soil from which they are taken up by the plants and used by them for food. The sun's rays, acting upon the leaves of the plants, causes starches, chlorophyll (the green substance in leaves) and other necessary components to be built up from the fertilizing materials and water in the soil and carbon dioxide gas in the air. The plant, in turn, gives off or exhales oxygen gas, that most necessary element in the air we breathe. All of these actions are chemical in nature. Quite a few of the life processes of plants have never been reproduced experimentally. They are still only vaguely understood. The action of the sun's rays in building up other materials, such as sugars from carbon dioxide in the plant, is known scientifically as "photosynthesis"—literally a "putting together by light."

THERE is another class of reactions that occur on the farm and elsewhere that have a very important relation to life. We refer to fermentations of various types. When milk sours, lactic acid fermentation has occurred and that acid is formed, and when cider ferments properly, vinegar, or acetic acid is the result. When common sugar, or sucrose, for there are nearly one hundred different sugars, ferments, grain alcohol is formed. This latter product is one of the most useful and versatile chemical compounds known today. Next to water, it will dissolve more substances than will any other solvent. It is used in the manufacture of perfumes, explosives, celluloid, varnishes and lacquers, medicines, flavoring extracts and in literally thousands of other preparations.

The houses in which we live are built largely of chemical products. If they are constructed of wood, we have already seen how plants themselves are chemical products. If the house is of concrete, this is a well-known chemical product, the action of the water in the "drying" concrete or cement causing the chemical changes necessary to produce the characteristics of concrete with which we are so familiar. Brick houses are constructed of a product which is formed by the action of water and heat. We all known that bricks must be "burned" before they become durable enough to be useful for building purposes. This, of course, is a chemical change. Stone houses are built of a naturally formed chemical product, such as granite, produced by millions of years of slow change. The water pipes, faucets, electric wires and fixtures—nearly everything in and about the home—are either strictly chemical products or are manufactured under strict chemical supervision.

The cooking of food is mostly a chemical process caused by heat. Baking causes the liberation of a gas, carbon dioxide, from baking powders. These preparations are scientifically made mixtures of chemicals so combined that heat causes the evolution of the gas, causing the cake to "rise." If yeast is used, warmth causes the yeast to grow, producing the same gas, carbon dioxide, together with some alcohol. Roasting, boiling—all cause many chemical changes in the food being prepared.

THE fabric of the clothing we wear, besides being synthesized by nature by means of what we know to be chemical methods, is bleached and dyed by chemical operations. These two, bleaching and dyeing, are very delicate and involved processes, requiring vast amounts of experimentation, technical knowledge and skilled work. The textiles must be bleached just right—enough to obtain the correct shade and not enough to cause "tendering" or embrittlement. Bleaching, briefly stated, is an oxidizing process that removes natural colored material. The application of dyestuffs to textiles requires the very finest class of workmanship and chemical supervision. There are several classes of dyestuffs, each one differing from the others in its chemical structure. Each class must be applied to the correct textile in a different way—some using acids, some alkalies, some mordants—and each class of dyestuff is suitable only for certain types of fabric—cotton, wool, artificial threads, silk, etc. One dyestuff, when applied to cotton, for instance, will produce a certain shade, while if applied to wool under the same conditions, will give an entirely different shade, or perhaps no color at all.

The water we drink is itself a very definite and unvarying chemical. It is composed of two gases, hydrogen two parts, and oxygen one part, chemically combined; hence, its formula is written, H_2O. The variations in the taste, appearance, odor, and actions of waters are caused merely by substances *dissolved* in them. Some waters contain limestone in solution, iron, salt, carbonates and bicarbonates, silica, and all sorts of things, or combinations of all or some of these. Absolutely pure water itself, which is a very difficult thing to obtain, does not vary—it being the product obtained by the combination of absolutely definite quantities of the two gases mentioned—hydrogen and oxygen. Water supplied for drinking purposes by most of the municipalities and larger towns is treated chemically to render it free from bacteria, germs, harmful salts in solution and sediment by a series of chemical treatments which may vary in different locations, according to the type of water to be treated. Thus chlorination or the addition of lime, alum, and such reagents, is resorted to in order that water supplies may be kept potable and absolutely free from all harmful substances. We hear of typhoid fever and dysentery much less frequently now than was the case a few years ago before the establishment of adequate methods for water purification and control. Those cases of which we hear are almost invariably traceable to the use of untreated water from contaminated sources of supply. Water purification, as it is now practised and as it is still evolving toward greater perfection, is a triumph of modern chemistry. Here we have water, an absolutely necessary material for every one, being rendered and kept perfectly pure and healthful, by the scientific addition of chemicals and by chemical treatment, and yet the taste of the raw, untreated and perhaps unsafe water is actually improved. This is one of the miracles of the day. The chemists who guard our water supplies must be continuously and absolutely on watch at all times to ensure an unfailing supply of safe water. It may very easily occur that the public's life is in the hands of the water chemists.

DISPOSAL of the huge amounts of waste from our large cities, the sewage, had until some time ago, been a great problem. It still is in a number of cities. Now, thanks to chemistry, sewage is not only disposed of satisfactorily and safely, but in many cases at a profit to the municipality. The sewage "sludge" is prepared for use as a good fertilizer, the fats are extracted, glycerin may be recovered and the effluent water from the sewage is so pure that it compares very favorably with the fresh water in the city supply. The very fires for heating and cooking in our homes are visible and tangible evidence of violent chemical reactions. The burning of coal, peat, wood, or oil is the combination of the combustible portions of these fuels with the oxygen of the air. These fuels are chemically formed in Nature. In this combustion, or burning, the chemical reaction is so violent that heat and light are emitted. The cinders or ashes remaining are the non-combustible materials in the original fuel, changed in appearance and composition by the action of the heat. The ash contains iron, sand, potash, oxygen, lime, aluminum—all of these and sometimes more. By analyzing the gases coming from your stove, chemists can tell whether your fire is burning efficiently and whether the draft is satisfactory. It is very interesting to note that the gas which comes off burning fuel most abundantly is none other than our old friend previously mentioned—carbon dioxide, the same gas that comes off when bread or cake is "rising."

But surely, you say, there must be something we use that isn't affected by chemistry. What of the newspapers we read, or the paper we use on the walls of our homes or with which we wrap articles? Yes, paper is a chemically prepared commodity, too, and a very important one. Rapid strides are still being made in the technique of paper-making. The supply of some of the woods long considered indispensable in newsprint manufacture are being depleted and grave fears were felt for the future. Chemists are coming to the rescue, however, and experiments with other and more plentiful and cheaper woods are showing excellent promise. Paper is made by treating rags, straw, or wood chemically.

Those of us who own automobiles may already know that each explosion in the cylinders of the engine is a violent chemical reaction. It is a sudden oxidation of the fuel being used, the reaction causing great heat, light, and the liberation of vast volumes of gases. The storage batteries used to start the engine or to furnish the lights of our automobile, or used to operate radios, are veritable storehouses, not of *electrical* energy, as so many assume, but of *chemical* energy. This is stored on the lead plates of the cells as lead peroxide which, when the electric circuit is closed, decomposes and releases electrical energy during this action. When the battery is "dead," the simple reason is that there is no more *chemical* energy in it. This energy may be built up again by passing an electric current through it for a long time until the battery is completely filled with its allotted amount of lead peroxide, a chemical compound. The sulphuric acid in the battery is a very necessary adjunct to the chemical processes occurring. The acid is known as the electrolyte.

This same sulphuric acid is one of the world's most valuable chemicals. It has been truly said that a nation's progress is measured by the amount of sulphuric acid it uses. This acid is absolutely necessary in the preparation of explosives, steel, petrol, lubricating oils, and thousands of other diversified products.

THE medicines used in the prevention and cure of various illnesses are, in great numbers, chemicals or combinations thereof. Some well-known examples of frequently prescribed medicines are bromides; alkaloidal drugs such as quinine and morphine; calomel and bichloride of mercury; aspirin, milk of magnesia, and magnesium citrate; spirit of ammonia and many others. Most of the newly invented drugs, hypnotics, anaesthetics, and such preparations are chemicals especially compounded as the results of definite chemical research for a definite result-producing drug. Cocaine did not serve its purpose entirely satisfactorily and so chemists got busy with their research programs and now we have procaine, butyn, apothesine, and similar substitutes for cocaine. These new ones are not as strongly habit-forming as are so many of the naturally found alkaloids. They are efficacious and not very toxic. It frequently occurs that physicians wish a medicine to fill an unfilled need. Chemists investigate the problem and proceed to develop the necessary new product.

Chemists are being called upon more and more to act as "detectives" in various lines. The control of drugs, foods, and fertilizers is in the hands of officially appointed chemical analysts. Countries having pure food and drug laws are saving their citizens vast sums of money every year in controlling the sale of adulterated and falsely advertised drugs, medicines, foods, and fertilizers. These products must all meet certain stringent rules and regulations and it goes rather hard with manufacturers who are neglectful.

There are today many and various branches of chemistry. Some examples are biochemistry, the chemistry of living organisms; stereochemistry, the arrangement of the parts of a molecule in space; electrochemistry, the relation of electricity to chemical changes; thermochemistry, the relation of heat to chemical changes; physical chemistry, that which relates to the chemistry of physical laws; phytochemistry, the chemistry of plant life. There are many other branches, covering nearly all lines of human knowledge and endeavor. The tendency of chemically trained men and women now is to specialize in one particular branch of chemistry and to become experts therein.

GOING far beyond our own terrestrial sphere, the earth, let us look just briefly at some of our celestial neighbors, billions of miles away. Surely there can be no chemicals or chemical reactions that far away, out in stellar space. Well, let us see. The sun has been very definitely proved to be primarily an immense globe of flaming hydrogen gas. The burning of hydrogen gas is a very vigorous chemical reaction, ordinary water being produced, besides great heat. This chemical reaction is the source of practically all of our earthly heat and light. Other materials are found on the sun also, calcium and helium gas being two of the best known. By spectrum analysis, one of the modern delicate methods of chemical analysis, it has been proved that on the sun and several planets there are metals and gases just as we have on our earth. Meteors which fall upon our earth from outer space contain iron, cobalt, and nickel, besides other elements in m nute traces. Where do these metals come from? The only logical answer now available is that they are formed by some interatomic chemical rearrangements in distant outer space in a manner similar to the way these same elements were formed on our earth, perhaps.

We have mentioned a very few of the ways in which the sciences, with particular reference to chemistry, are intimately bound up with our everyday lives. The ramifications are manifold—there appears to be no known end and there probably can be no end, as long as man sets himself to inquire into the mysteries of nature. Many of his findings mean the discovery of other and better ways of aiding his fellow men.

The very bodies which we call ours are composed of a complex mixture of chemical compounds intimately bound together and forming a living, breathing form. Most of life's most necessary processes are chemical reactions over which we have little or no control. We eat food. The processes of digestion are strictly chemical reactions, whereby the ingested food is turned into other and totally different substances capable of being absorbed into the blood stream, where they are oxidized by the oxygen we breathe into our lungs, to supply the necessary fuel and means of growth to keep the body in working order. After all, it does look as though chemistry plays a more or less important part in our ordinary lives. It rules our lives and affects us vitally at every turn and there can be no getting away from it.

INSTITUTE NOTES

National Council

October Meeting

The one hundred and fifteenth meeting of the Council of The American Institute of Chemists was held at The Chemists' Club, 52 East 41st Street, New York, N. Y., on Thursday, October 18, 1934, at 6:30 o'clock P. M.

President Dr. M. L. Crossley presided.

The following Councilors and Officers were present:

Messrs. Crossley, Kenny, McBurney, Moody, Zons and Miss Wall.

In the absence of Secretary Howard S. Neiman, Miss Vera F. Kimball acted as Secretary pro tem. The minutes of the previous meeting were approved. In the absence of the Treasurer, the President presented the Treasurer's report showing a cash balance as of October 18, 1934, of $1,488.62. Upon motion made and seconded, the Treasurer's report was accepted.

The report of the Committee on Budgets was presented by Dr. Zons, showing estimated receipts from dues, advertising, and subscriptions of $5,360.04, and estimated expenditures for rent, stationery, salaries, printing, rebates, etc., of $5,290.40. Upon motion made and seconded, the report was accepted.

The President read a progress report from the Committee on Emblems. A report was received from the Pennsylvania Chapter showing the officers and committees of that Chapter for the current year. It was moved and seconded that the Secretary write a letter to Mrs. Henry Arnstein, expressing the appreciation and loss of the Council for the faithful service of its recently deceased member, Dr. Henry Arnstein. Motion carried.

Miss Wall reported for the Committee on Design for medals for Chapter awards and on motion made, seconded, and carried, she was requested to communicate with Dr. James F. Couch for his suggestions, and to bring a tentative form of medal to the next Council meeting. A report from the Committee on Unemployment and Relief for Chemists and Chemical Engineers was read.

Miss Kimball was instructed to prepare a list of all members whose dues are in arrears and submit it to the next meeting of the Council. It was moved, seconded, and carried, that in order to save expense the roster be printed as a separate pamphlet instead of being incorporated into an issue of THE CHEMIST.

Dr. W. T. Read, of Rutgers University, was appointed Chairman of the Committee on Membership. The President and Councilors made numerous suggestions for the consideration of the Committee on Membership, and the President requested the Secretary pro tem to send a copy of these suggestions to each member of that Committee, and ask the Committee to meet at an early date. The Secretary pro tem reported on the present status of the membership.

The President appointed Miss Wall to act as a "news reporter" for the Council in cooperation with the Editor of THE CHEMIST, for the purpose of bringing the activities of the Council more fully to the attention of the membership. There being no further business brought before the meeting, adjournment was taken.

Pennsylvania Chapter

The first meeting of the 1934–1935 season was held in the Board Room of the Engineers' Club on Tuesday, October 2, 1934. Our new chairman, Mr. Stoertz presided. The chairman officially called the attention of the chapter to the death of Dr. Arnstein which had occurred during the summer vacation and read a letter of condolence which the secretary had sent to Mrs. Arnstein. On the motion of Dr. Taggart, the letter was ordered spread upon the minutes. The letter reads as follows:

"July 31, 1934

"Dear Mrs. Arnstein:

"On behalf of myself and my fellow members of the Pennsylvania Chapter of the American Institute of Chemists, of which institute Dr. Arnstein was a very active member, I am writing to express to you our deepest heart-felt sympathy. Although we know that the mere fact that many sorrow with you will not assuage your grief, yet we hope that you will permit us to sit with you in mourning for the great soul, the inspired scientist and our beloved co-worker whose deeds and spirit will always continue to be an inspiration to us.

"Very sincerely yours,

(Sgd.) CHARLES W. RIVISE
Secretary, Pennsylvania
Chapter, A. I. C.

"Mrs. Henry Arnstein
191 E. Roosevelt Blvd.
Philadelphia, Pa."

Mr. Chapin reported that the Technical Service Committee had received less calls for assistance than had been contemplated and that it still had funds left from last year.

After the business meeting, Mr. Chapin discussed "The Chemist in Public Service in This Country" and Mr. Newitt led a discussion on "The Chemist in Public Service Abroad."

The following is the roster of officers and committees:

Howard Stoertz, *Chairman*
Max Trumper, *Vice-Chairman*
C. W. Rivise, *Secretary and Treasurer*
Herbert S. Schenker, *Reporter*
C. W. Rivise, *Chapter Representative* to the National Council

Committee to Interview Unemployed Chemists:

Wm. Stericker, *Chairman*
E. F. Cayo
H. S. Lukens

Program Committee:

F. Jones
J. E. Chapin
L. L. Jenne
Max Trumper

Communication from Philadelphia Chapter

A new manager of the Employment Bureau of the Technical Service Committee of Philadelphia has been secured in the person of Mr. Wm. L. Fitzgerald, who brings to the aid of the bureau a record of a number of years of experience in private employment agencies.

One of Mr. Fitzgerald's first acts was a careful analysis of the unemployment situation in the Philadelphia district, together with a study of the methods and aims of the Technical Service Committee.

The Committee has expended nearly $56,000.00 and has secured positions for about 350 men. In addition to the actual placements recorded, the Committee has been in a position to give advice to a great many men as to how they, themselves, might better their condition.

During the earlier period, owing to the distressing conditions which then existed, the Committee concentrated practically all their efforts in rendering financial assistance, but with the decreasing need for such activities it has become increasingly evident that much better work could now be accomplished by concentrating on the activities of the employment phase of the Committee's work.

During the first year the Employment Bureau was staffed entirely by volunteers, and great good was accomplished, even though many of the practical realities of the problems confronting an Employment Bureau were not thoroughly studied.

It has long been the belief of many members of the Affiliated Societies that the Engineers' Club should become a center for all technical activities, and that the Employment Bureau should be so organized that the employer and employee alike would naturally turn to this service.

With this thought in mind, the Committee secured expert advice and immediately found that the employment business was an intensely practical business, and one which must meet the competitive conditions which exist, but, nevertheless, one which can be operated in accordance with the highest professional and ethical standards.

During the first year the employment bureau operated a free service, but it was felt that if the bureau was able to secure positions for technical men they should be prepared to contribute to the support of the bureau; and, therefore, a state license was taken out and a fee charged, amounting to about five days' salary, which is less than one-half the fee charged by other agencies.

All that is now needed to make the Employment Bureau a complete success is the continued and enlarged use of the Bureau, both by the employer and the employee.

With particular reference to the chemist, it has been the experience of all employment bureaus and agencies, that the chemical employer and the unemployed chemist do not make full use of employment bureaus, with the result that neither the employer nor applicant can be served to the same extent as is true in other technical fields.

At the present time the chemical registrations are as follows:

Total number of applicants........	137
Between 26 and 40 years of age....	62
Under 26 years of age..............	53
Over 40 years of age...............	22
A.C.S. members	38
Members of other societies..	13
Members of Engineers' Club.	1

It is to be hoped that employers will make enlarged use of the Bureau, and that unemployed chemists should register and also keep their applications active.

HOWARD STOERTZ

BOOK REVIEW

ORES AND INDUSTRY IN SOUTH AMERICA. By H. FOSTER BAIN and THOMAS THORNTON READ. A publication of the Council of Foreign Relations. *Harper and Brothers*. New York. $3.50.

The purpose of this book is to explain the mineral resources of South America, the part they have played in its history and development, and the part they may be expected to play in its future. A series of conferences held by the Minerals Group of the Council on Foreign Relations in 1931 and 1932 provided much material for this volume, although personal notes made by the authors while in South America on various investigations concerning ores and industry, and information obtained from published literature, also contributed to the survey. It does not contain a bibliography, which would seem valuable to a work of this kind, but does contain reference to texts which have full bibliographies, and occasional reference to more recent publications.

The first chapter states the problem: the popular belief in vast undeveloped resources of South America; and gives a survey of general resources. Next comes a description of the land and peoples, and the origin and early history of mineral developments. The individual countries are then taken up in detail, followed by a list of the owners of the mineral concessions and their financing. The final chapter is a summary of the mineral and industrial history, and the conclusion that

"The history of financial investments in South America for the past two decades gives rise to the sobering reflection that the spirit which impelled the quest for the gilded man (El Dorado) has apparently not altogether vanished. The impulse to believe in great possibilities needs the check of careful measurement and precise appraisal."

The mineral future of South America probably lies in petroleum and the industrial ores. Gold and silver and other precious and semiprecious stones are fairly rare, despite popular tales. The age of Inca gold is past. The development of mineral production for domestic consumption is likely to increase slowly as the character of the people may change. The difficulties in the way of export are mainly the inaccessibility of South America to the rest of the industrial world.

This book is not intended as a text for the mineral geology of South America, but it is planned rather for the use of students of social and economic subjects. Although slightly academic it offers a valuable and intelligent survey of the possibilities of future mineral investments in South America. V. F. K.

Dr. Edward R. Weidlein, Director, Mellon Institute of Industrial Research, Pittsburgh, Pa., has announced that the Onyx Oil & Chemical Company, 15 Exchange Place, Jersey City, N. J., has founded an Industrial Fellowship in that institution. This Fellowship, whose incumbent is Dr. Robert N. Wenzel, is concerned with the scientific investigation of problems in textile processing and finishing.

Dr. Wenzel has been an Industrial Fellow of Mellon Institute since 1927. He received his A.B. at Stanford University in 1916 and his Ch.E. the following year; subsequently, in 1928, after serving as a research chemist at the Monsanto Chemical Works (1918–1922) and after five years of teaching at Stanford, he was awarded the degree of Ph.D. by that university. He is a specialist in organic chemistry who is best known professionally for his comprehensive studies of fatty acids and related compounds.

In his investigations for the Onyx Oil & Chemical Company, Dr. Wenzel will have the close cooperation of the textile specialists on the Institute's research staff. At present the Institute has five different Fellowships in the field of textile technology.

W. J. Baëza, of the Industrial Research Company, has rented additional space and now has an office in the Chemists' Building, 50 East 41st Street, New York City.

The death of Ivan A. Frane, A.A.I.C., has just been reported to the Institute although it occurred some months ago. Mr. Frane was an assistant engineer with the Illinois Division of Highways, Springfield, Illinois, and had been a member of Institute since 1924.

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